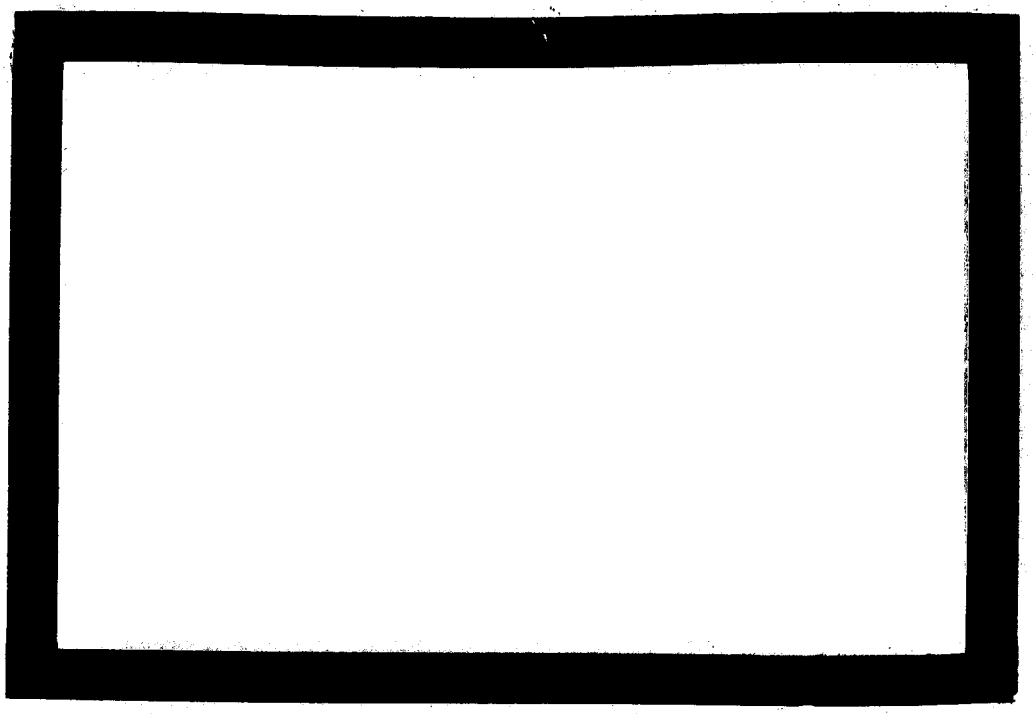
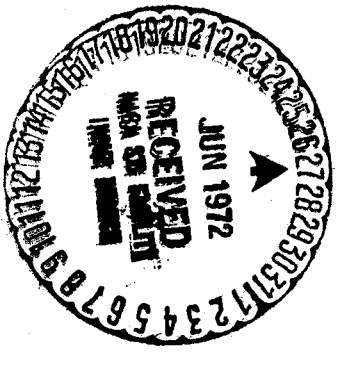
NGR 19-011-007





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PHYSICS
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Grambling, Louisiana

Spectral and Polarization Analysis of Micropulsations Observed at ATS-1

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May, 1972

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Abstract

Spectral and Polarization Analysis of Micropulsations Observed at ATS-1. This paper reports the results of an analysis of low-frequency oscillations in the earth's magnetic field as observed at the synchronous orbit by the UCLA magnetometer experiment on board ATS-1. Oscillations in the range $2 \times 10^{-3} < f < 20 \times 10^{-3}$ Hz for the one year period Dec. 1966 through Dec. 1967 were studied. The analysis combines a detailed, computer processed, spectral analysis of selected events with a less detailed manual analysis of all events in the two year time interval. The computer analysis revealed that a given event is often characterized by a dominant, narrow, spectral peak whose associated oscillations are almost entirely limited to a plane, together with several minor peaks. Dynamic spectral analyses reveal that the minor spectral peaks appear as short isolated bursts. The sense of rotation of the perturbation vector tends to change from right-handed elliptical at the beginning of a burst to left-handed elliptical at the end. The major axis of the polarization ellipse is inclined by typically 30° east of radial.

In this paper we report on some characteristics of the magnetic oscillations in the Pc4 range that occur at the geosynchronous satellite ATS-1. The events chosen were those in 1966 and 1967 that had durations greater than six (6) hours. The principal conclusions at this point in the analysis are:

(1) The oscillations appear to occur in bursts of approximately one hour duration.

(2) There appears to be a trend in the sense of rotation of the perturbation vector during a burst. The sense of rotation changes from right-handed elliptical at the beginning of the burst to left-handed elliptical at the end.

(3) The azimuth of the major axis of the polarization ellipse is inclined by typically 30° east of radial.

Slide 1. The first slide shows the result of an eigen-analysis of the real part of the spectral matrix for a typical quiet time event. The procedure of the analysis is equivalent to creating the variance ellipsoid of the perturbation at a given frequency interval and determining the length and orientation of its eigenvectors. The important point of the slide is the sharp peak in the power density at about 5 milli-hertz (or a period of about 200 seconds) with a rms power of 1 γ.

The bottom portion of the slide indicates that the average polarization was 80% and almost completely linear. However, as we shall show later, the ellipticity varies systematically throughout each of the bursts making up an event. The variation is such that the sense of rotation is right handed as often as it is left handed. This accounts for the average polarization being linear.

Slide 2. The next slide shows the dynamic power spectrum for oscillations in the plane transverse to the dipole axis. There were three bursts centered at 1811, 1931, and 2248 U.T. The first two bursts are of 171 second period and the third burst is of 213 second period. The time derivative of the signal is plotted above the dynamic power spectrum. The contour map is a dynamic spectrum of the derivative of the transverse signal.

Slide 3. The next slide shows the log of the power, the ellipticity, and the azimuth of the major axis of the polarization ellipse for the component of the signal at the frequency of peak power. The significant point of the slide is that at at each point when the signal power was maximum the ellipticity changed from positive, or right handed, to negative or left handed.

We have found no such systematic variation of the orientation of the major axis of the polarization ellipse in the events analysed to date.

Slide 4. The next slide shows in more detail the change in the sense of rotation of the perturbation vector at peak power. We have plotted the transverse components of the magnetic field during a typical short duration burst. On the same time scale we indicated the polarization ellipses as determined from an eigen value analysis of the transverse data. The ellipticities before and after the peak power point are typically .3. The sense of rotation is right handed before the point of peak power and left handed afterwards.

The major axis of the polarization ellipse is inclined to the radial by 30-40° throughout the burst.

Slide 5. To date we have yet to find a significant dependence of the orientation of the major axis of the polarization ellipse on any of the usual magnetic indices. However, we have found that the major axis of the polarization ellipse is generally inclined east of radial. This slide shows the results of several determinations of the azimuth of the polarization ellipse for each of the long duration events of 1966 and 1967. The most frequently measured azimuth angles are in the range 20-40°.

In summary we have found that the Pc4 events observed at ATS-1 occur in bursts of typically 1 hour duration. The sense of rotation of the perturbation vector usually changes from right handed to left handed at the peak power point. And finally the major axis of the polarization ellipse is usually inclined by about 30° east of radial.

Acknowledgements

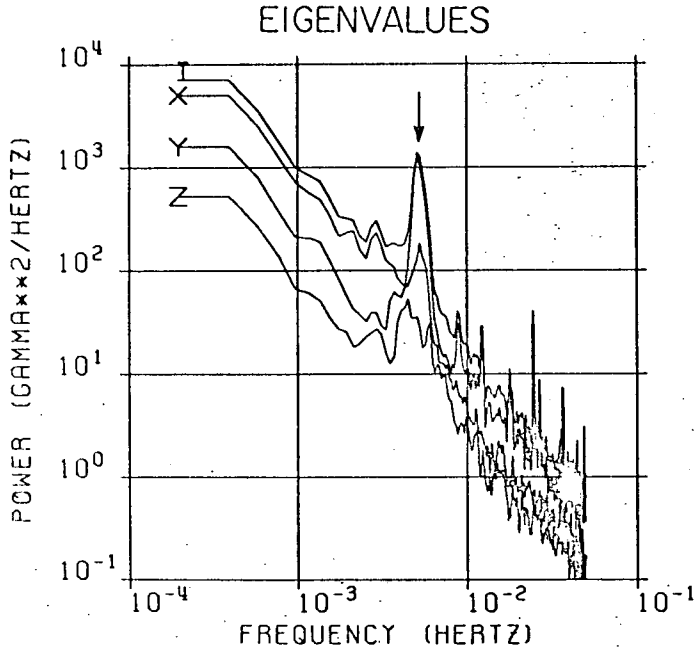
The work done at Grambling College was supported by The National Aeronautics and Space Administration grant NGR-19-011-007. The work done at UCLA was supported by The National Aeronautics and Space Administration grant NGL-05-007-004.

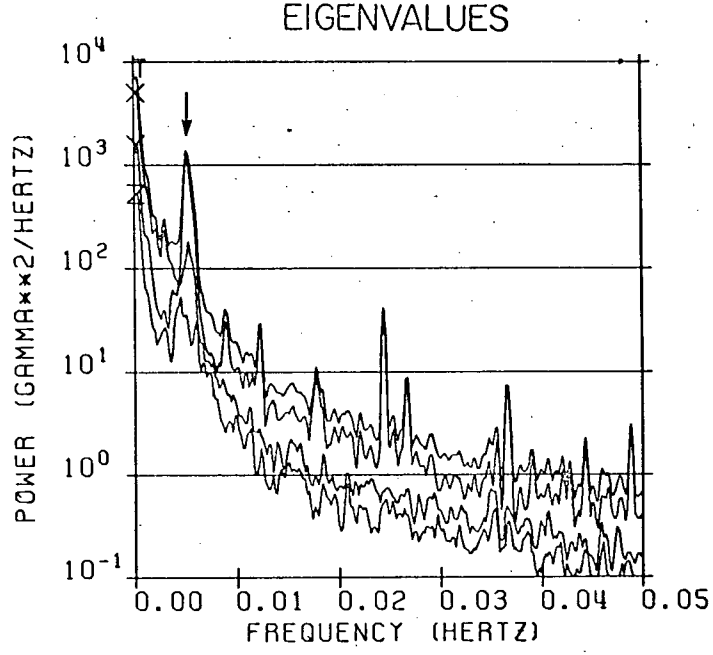
Pc4-5 MICROPULSATIONS

UCLA Fluxgate Magnetometer

ATS-1

1400-0122, 5-6 JAN. 1967





SPECTRAL ANALYSIS PARAMETERS

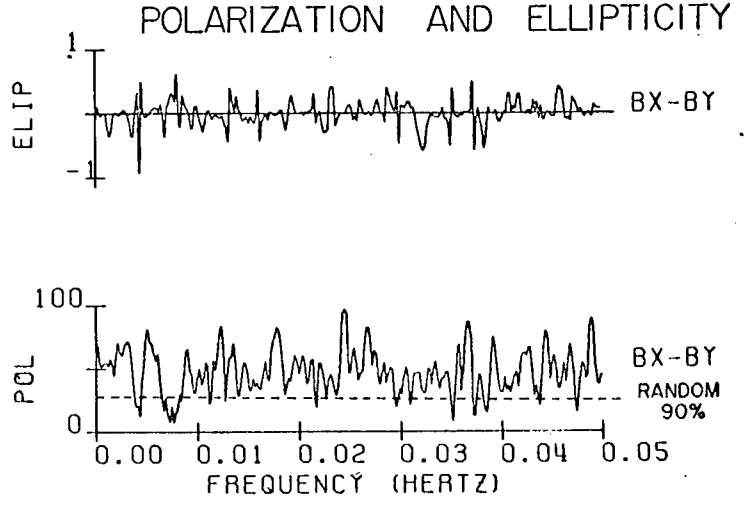
SAMPLE INTERVAL = 10.0 SEC

DEGREES OF FREEDOM = 26

NUMBER OF POINTS = 4096

BAND WIDTH = 0.32×10^{-3} HZ

BAND SEPARATION = 0.20×10^{-3} HZ

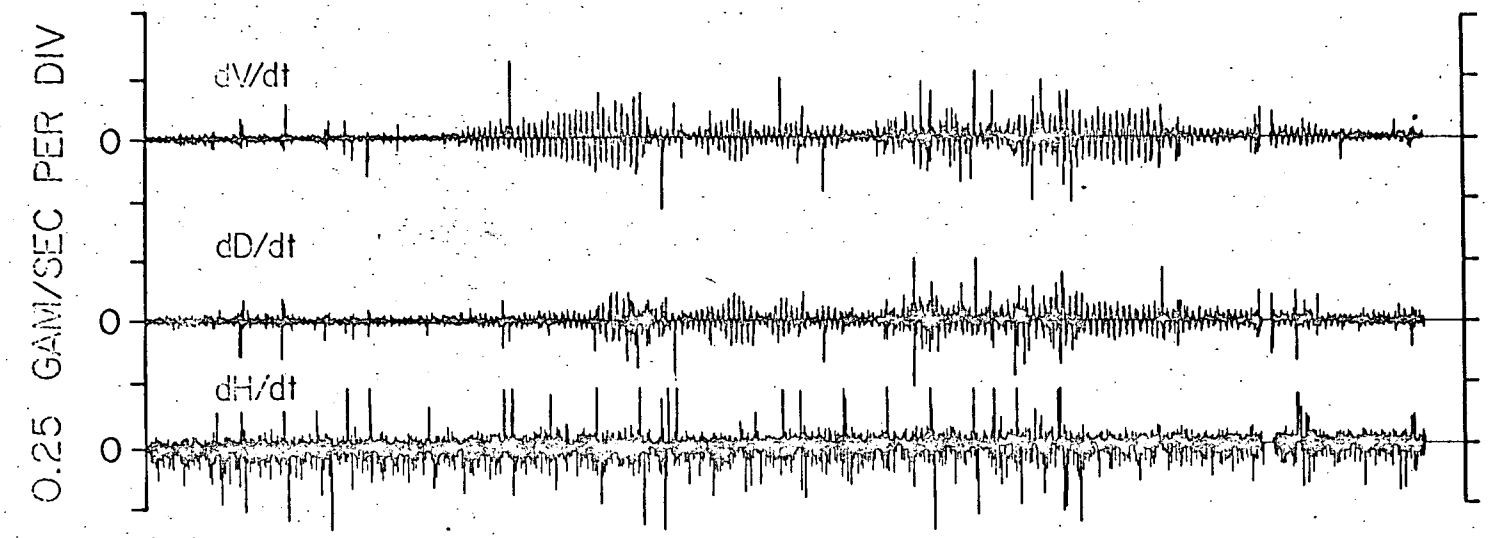


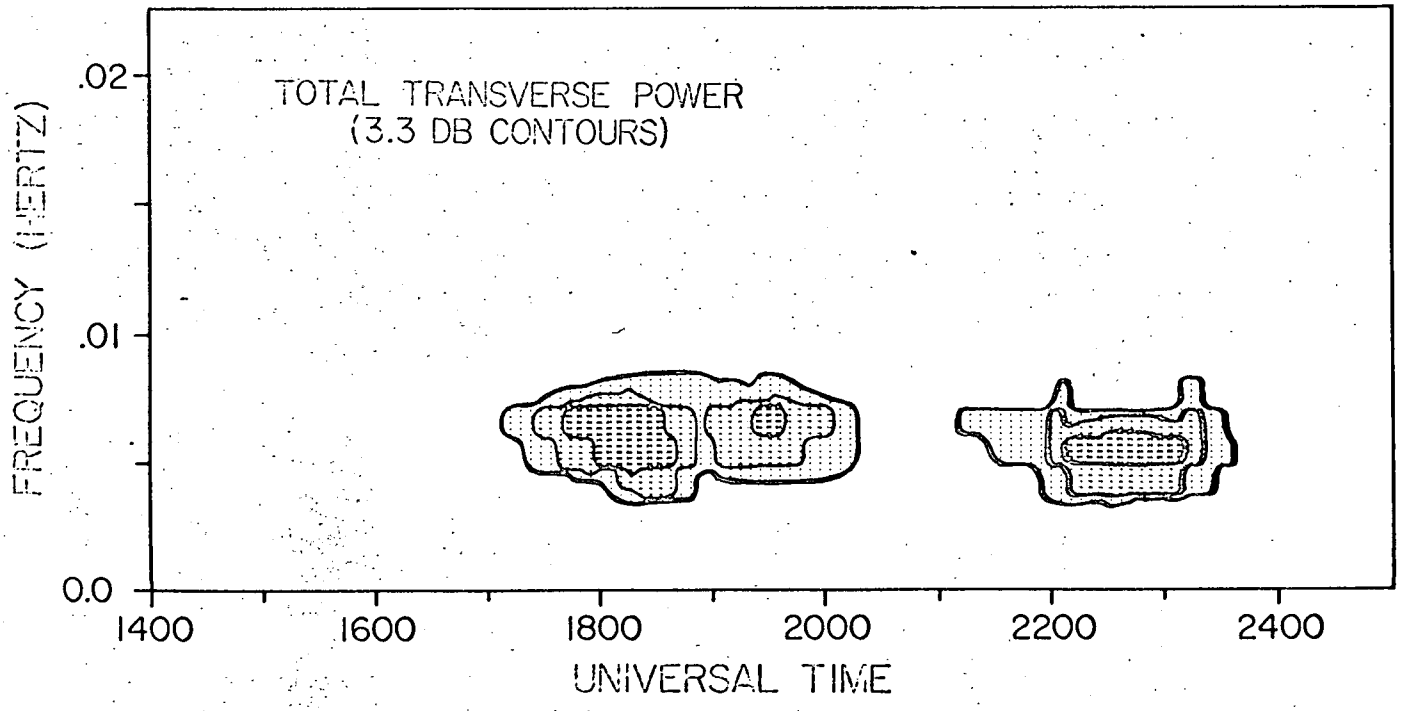
Pc4-5 MICROPULSATIONS

UCLA Fluxgate Magnetometer

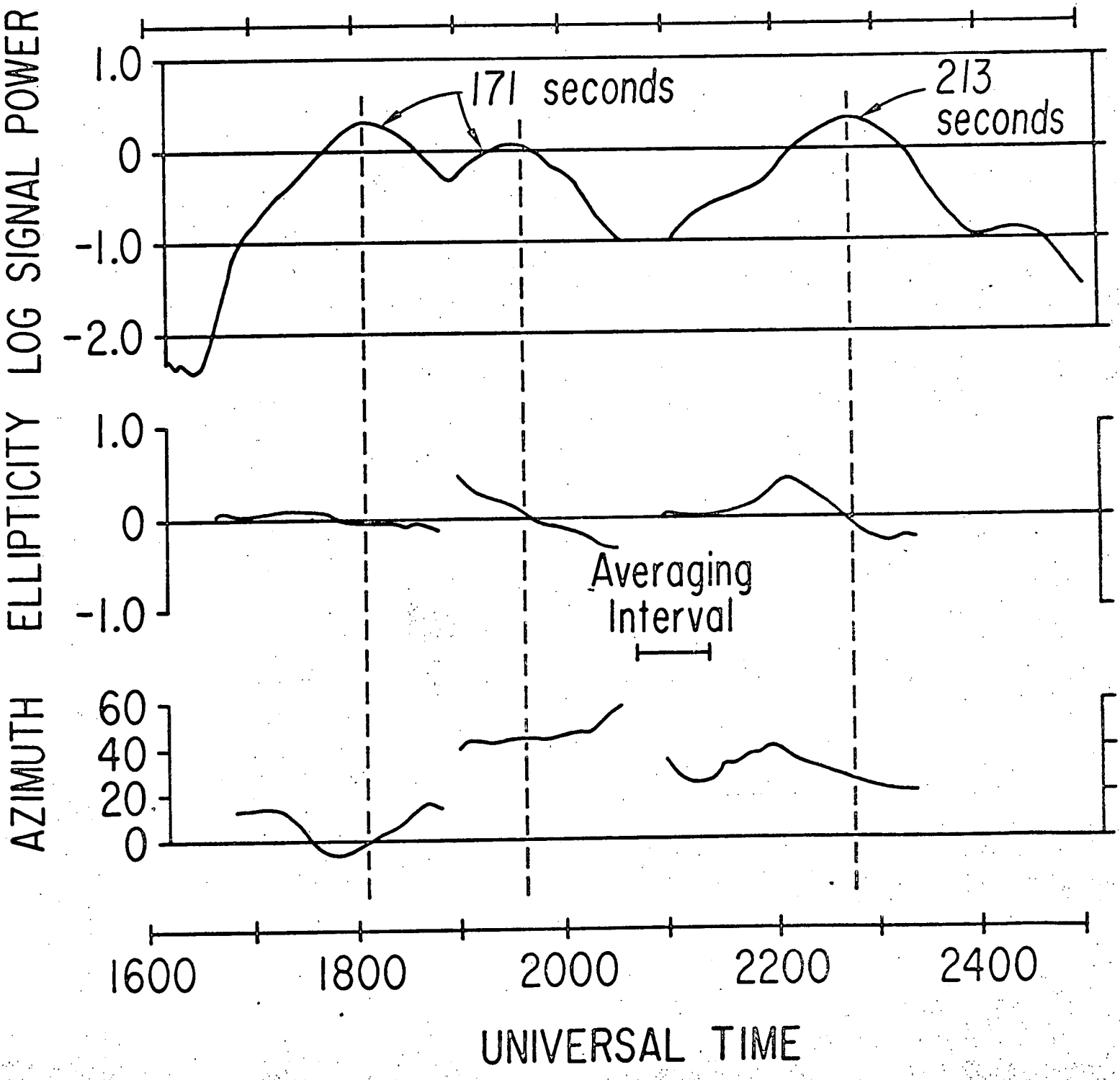
ATS-1

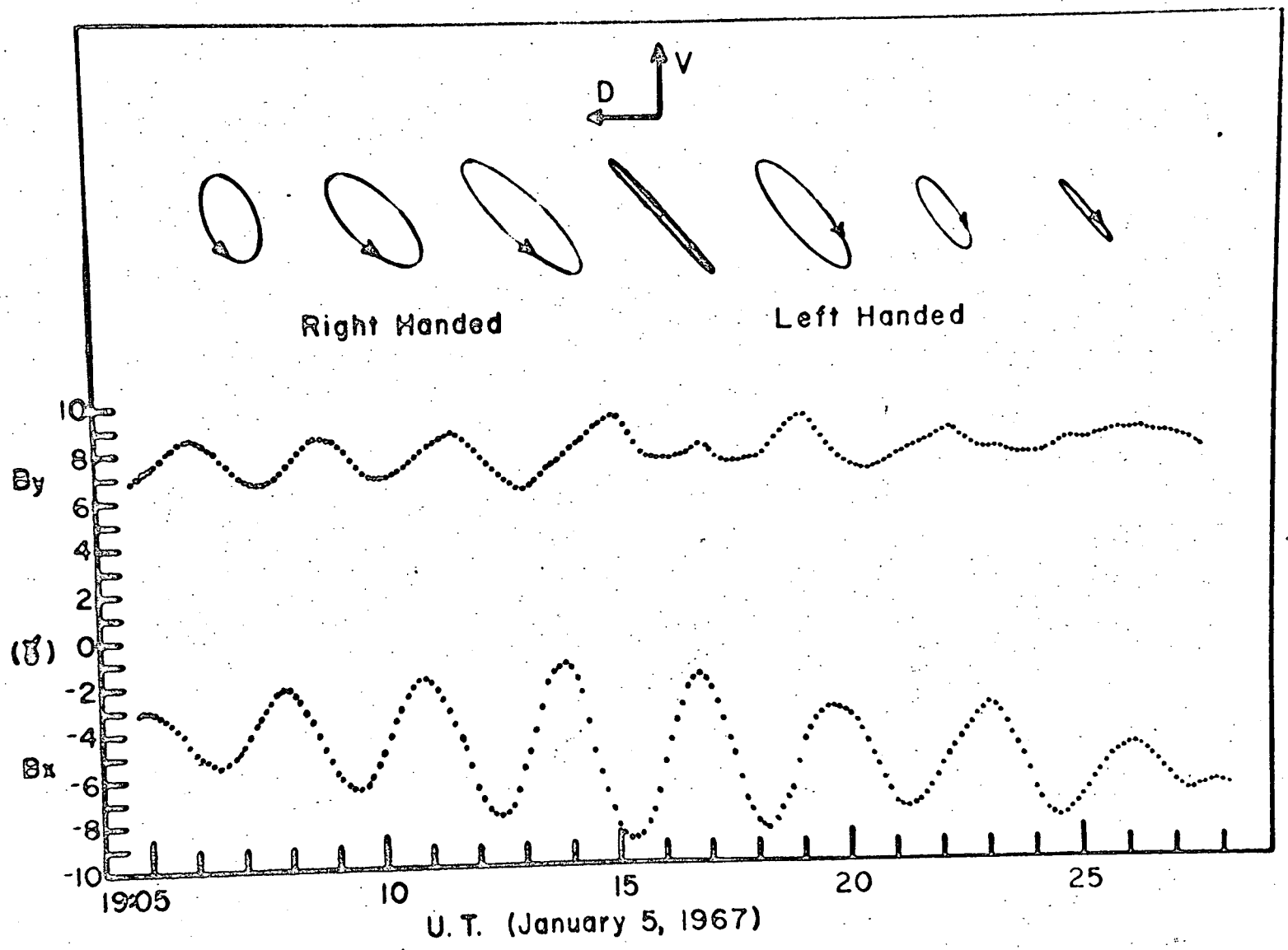
JANUARY 5, 1967





Pc 4-5 MICROPULSATIONS
UCLA FLUXGATE MAGNETOMETER
ATS-1
JANUARY 5, 1967

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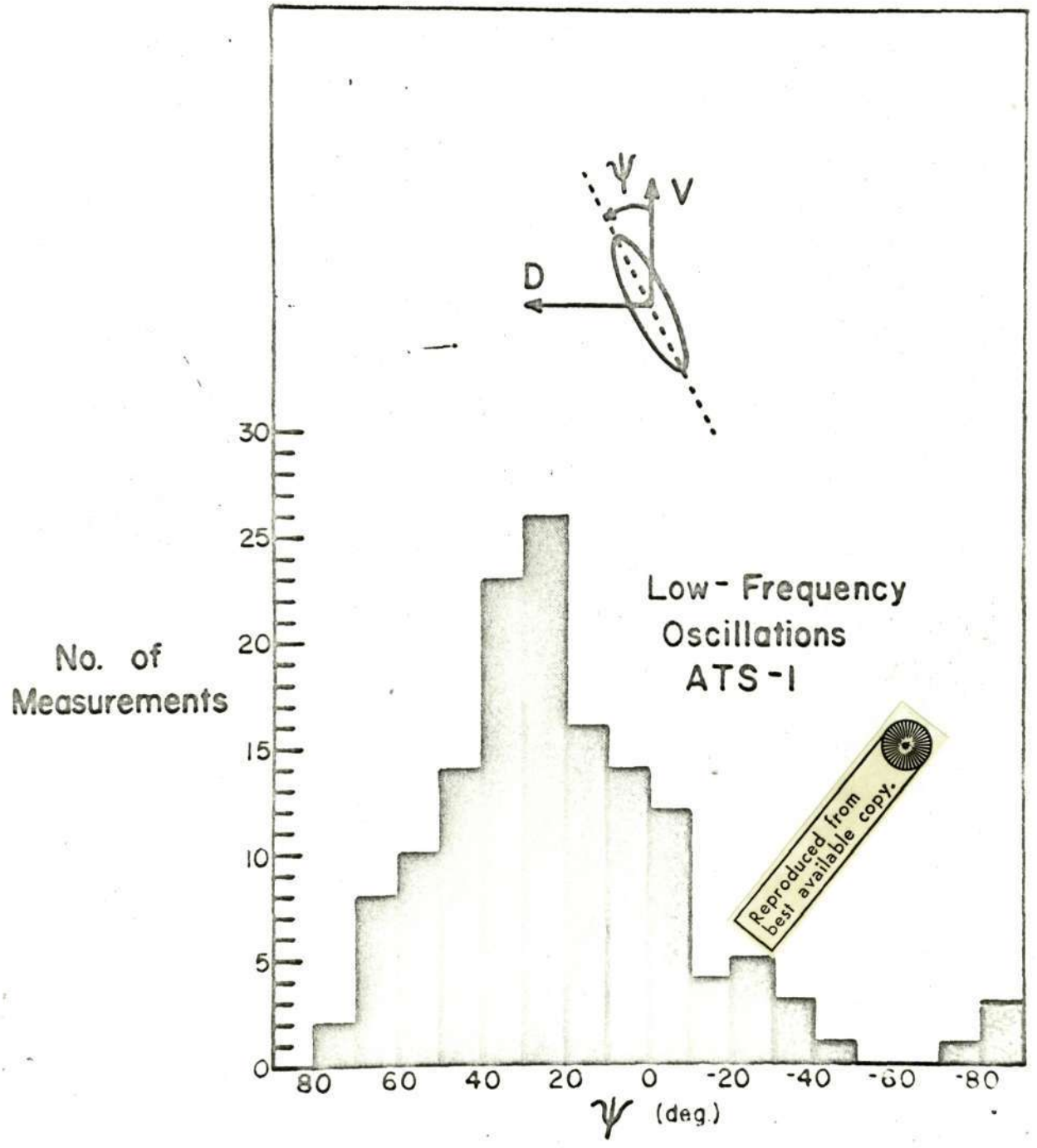
U. T. (January 5, 1967)

Slide 4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Slide 5